

EXHIBIT B. 8.

**July 16, 2000 US Wireless Report "Nextel RadioCamera™
Technology Trial: USWC Post-Processing Performance
Analysis."**



Nextel RadioCamera™ Technology Trial: USWC Post-Processing Performance Analysis

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1 Introduction

This report documents performance results for the recently completed Nextel RadioCamera™ Technology Trial conducted 02-07 June, 2000 in Washington DC. The analysis presented here was performed by US Wireless Corporation, and incorporates system optimization and post-processing techniques applied to the trial data collections previously completed. This analysis includes a subset of test points and mobile routes located in the Virginia portion of the trial test region. All analysis was performed without knowledge of the true locations of the test points and routes; therefore, all performance statistics presented herein are estimated results only.

2 Data Set Description

2.1 Test Points and Mobile Routes

The data processed in this analysis includes a subset of the test points and mobile routes located within the Virginia portion of the Nextel test region. A total of 10 stationary points and 2 mobile routes were evaluated including:

- Stationary Test Points: 1-7, 28, in/out1 (40), and in/out2 (41);
- Mobile Test Routes: MC2 and MC4.

Stationary Point 27 was omitted from this analysis since it was located well outside the designated trial region, and in an area incompletely calibrated by the RadioCamera™ system.

Eight of the ten stationary points appear to be located near the boundary of the test region, and near the edge of the RadioCamera's™ calibrated region. Three of these points appear to be outside the designated test region. As such, the majority of the test points under evaluation are considered to be located within the fringe area of the RadioCamera's™ coverage (see Figure 1).

A substantial portion of Mobile Test Route MC4 also appears to be outside of the designated test region, as well as a small portion of Mobile Test Route MC2.

2.2 Data File Submission

A complete set of post-processed data files has been created as part of this analysis. Three files have been created for each of the test points and mobile routes, for each day of testing. The three files represent the first fix, best fix, and all fix data. A complete list of the submitted data files can be found in Appendix A.

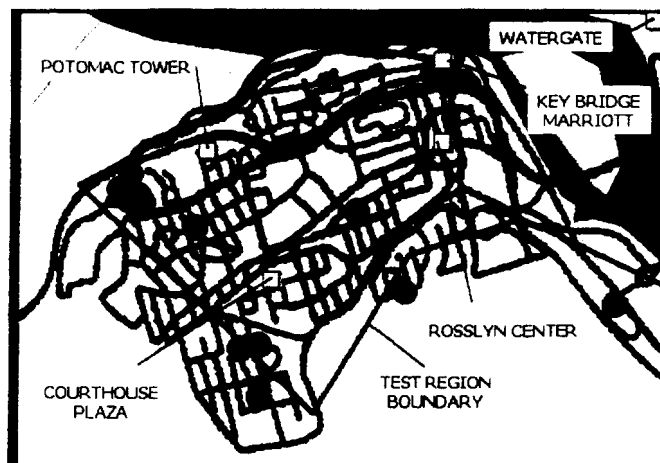


Figure 1: USWC estimated locations for the 10 stationary test points. The black line indicates the defined test region boundary. Green lines indicate portions of the test region that have been calibrated. Yellow squares represent the five RadioCamera™ sites used in the performance analysis. Point 40 represents the “in-out 1” test point and Point 41 represents the “in-out 2” test point.

3 System Optimization

3.1 Overview

The RadioCamera™ system performance has been optimized by two methods: (1) post-processing software, and (2) parameter optimization. The post-processing software was developed to correct synchronization and latency errors discovered in the RadioCamera™ data network. These errors were due to the use of a wireless data network originally intended for temporary use only. Parameter optimization was performed according to standard tuning procedures, based on results of drive test analysis performed during the period 12-14 July, 2000.

The testing and analysis documented in this report is limited to the set of test points and mobile routes located in Virginia, therefore the RadioCamera™ network has been restricted to only those sites with adequate “hearability” in this region. A subset of five RadioCamera™ sites was used in this analysis, as shown in Figure 1.

To facilitate the drive test optimization and alleviate future data synchronization issues, the RadioCamera™ data network was converted to a frame relay network on 11 July, 2000. Note that this conversion has no impact on previously collected data or trial performance results.

Specific areas of analysis and optimization are discussed in the following sections.

3.2 Data Network Synchronization

Post-processing software has been developed to correct data network synchronization errors induced by network latency. Two types of errors arose as a result of this synchronization issue: (1) RadioCamera™ Base Unit (RBU) tasking errors, and (2) RBU reporting errors. The first error type resulted in the RBUs being tasked late, which in turn potentially caused the RBUs to collect data on an idle or reassigned iDEN channel. The post-processing software searches for these error types and removes all incorrect data. Note that with Type 1 errors, the data cannot be corrected and is simply discarded. The percentage of data loss due to Type 1 synchronization errors is summarized in Table 1. The second error type, related to late RBU reporting, is corrected by realigning the RBU data reports based on their GPS timestamps. This type of error was completely corrected with post-processing software.

Table 1: Percentage loss of data due to Type 1 synchronization errors.

TEST DATE	ORIGINAL SAMPLES	FILTERED SAMPLES	% DATA LOSS
02 JUNE	5830	5207	10.686
03 JUNE	6251	5048	19.245
05 JUNE	6266	5420	13.501
06 JUNE	7153	6146	14.078
07 JUNE	6948	6461	7.009

3.3 Calibration Table Analysis

Based on drive test data obtained on 12-14 July, 2000, an analysis of the RadioCamera™ calibration table was performed for the five sites serving the Virginia test region. Four of the sites passed with good / moderate performance, and one site passed with marginal performance. The calibration table integrity is characterized by a performance measure referred to as “point-match”, indicating the closeness of fit between components of the calibration table. A point-match of 0.9 or better is considered excellent. Within the range of 0.8 – 0.9 is considered good, while anything below 0.8 is marginal or failing. A summary of the calibration table point-match for the five trial sites is summarized in Table 2. The principal cause for a point-match failure is insufficient calibration data density, and typically requires additional calibration data collection to pass. As a reference, typical point-match performance for sites in the USWC Oakland, CA deployment is 0.87.

Table 2: Calibration table point-match for the five trial sites.

RadioCamera™ SITE	POINT-MATCH	QUALITY
Rosslyn Center	0.86	Good
Potomac Towers	0.85	Good
Key Bridge Marriott	0.81	Moderate
Watergate	0.82	Moderate
Courthouse Plaza	0.73	Marginal / Poor

3.4 Parameter Optimization

Based on analysis of drive test and audit data, a set of optimal RadioCamera™ system parameters has been determined. These parameter and their influence are briefly described as follows.

3.4.1 Matching / DF / Tracking Parameter

A family of parameters is associated with establishing the interoperation of the basic components of the location engine. These parameters control the relative influence of the three location processes: (1) signature matching, (2) direction finding, and (3) Kalman tracking.

Upon completion of the drive test performance analysis, it was determined that the existing settings for the Matching / DF / Tracking parameters were correct, and no changes were made to this parameter set.

3.4.2 DTX

DTX optimization is controlled by a single parameter that automatically extends the effective RadioCamera™ observation interval to ensure adequate density of data samples for each location estimate. This parameter was retuned based on drive test data analysis, and is now operating satisfactorily. The previous system setting had fixed the maximum effective integration period to 2.3 seconds. This is now extended as needed to obtain the proper data sample density.

3.4.3 Quality Factor

A RadioCamera™ quality factor is determined for each location estimate, and is used to select the highest quality measurement to be reported in the required time interval. The parameters controlling quality factor estimation have been reset. However, in order to fully realize the benefits of the quality factor, it is desirable to complete the Courthouse Plaza calibration table.

3.5 BSC Interface Latency

During the trial, all call events (*e.g.*, initiations, handoffs, and terminations) were reported to the RadioCamera™ Hub through a BSC Gateway designed for this trial. Due to the lack of a common timing reference between the Nextel and USWC systems, it was difficult to assess the

latency (if any) of communications over this link. However, it was noted that there appeared to be a high correlation of errors (location outliers) associated with measurements made just prior to a handoff or termination event report. If the event report was acquired late, or processed with any delay, the RadioCamera™ system might remain collecting on an idle or reassigned iDEN channel resulting in a corrupted location estimate. To mitigate this effect, the post-processing software filtered those points occurring just prior to a handoff event. The percentage of data loss due this filtering operation is summarized in Table 3.

Table 3: Percentage of data removed due to potential handoff & call termination latency.

TEST POINT	ORIGINAL SAMPLES	FILTERED SAMPLES	% DATA LOSS
01	916	842	8.08
02	618	604	2.27
03	536	473	11.75
04	590	567	3.90
05	640	624	2.50
06	567	513	9.52
07	398	372	6.53
28	426	404	5.16
40	516	506	1.94
41	571	514	9.98

4 USWC Performance Analysis

4.1 Methodology

In this analysis, USWC was not given knowledge of the ground-truth for the set of test points. Therefore, the true location must first be estimated in order to produce a reference for determining the location error statistics. The estimated location reference for each stationary point is obtained by simply determining the 2-dimensional centroid for all data collected at that point. Using this centroid as a reference, the PDF and CDF of the location error are established, and the 67th and 95th percentile performance is obtained.

The trial audit data is first post-processed to remove all synchronization & latency errors as described in the previous section. The filtered data is then processed to determine the location estimates using the recently determined optimal system parameters. These results are reported in the following section.

4.2 Results

A summary of performance results is presented in Tables 4 and 5. A composite location error scatter plot is also provided to illustrate the nature of the error distributions with respect to the 100m and 300m performance requirements.

Table 4: Stationary test point performance summary – all fixes reported every 2.3 seconds.

TEST POINT	≤67% (m)	≤95% (m)	≤100m (%)	≤300m (%)
01	108	312	65	94
02	131	236	56	97
03	71	373	82	94
04	123	570	61	90
05	54	122	88	100
06	266	707	36	71
07	131	285	61	96
28	54	491	80	87
40	151	403	53	85
41	156	1272	51	87
COMBINED	113	447	64	91

Table 5: Stationary test point performance summary – best fix reported within 30 seconds.

TEST POINT	≤67% (m)	≤95% (m)	≤100m (%)	≤300m (%)
01	81	274	72	97
02	99	214	66	98
03	51	102	90	100
04	73	522	77	90
05	29	112	93	100
06	231	527	34	83
07	71	236	76	100
28	51	113	92	95
40	176	344	53	90
41	147	229	59	95
COMBINED	90	303	71	95

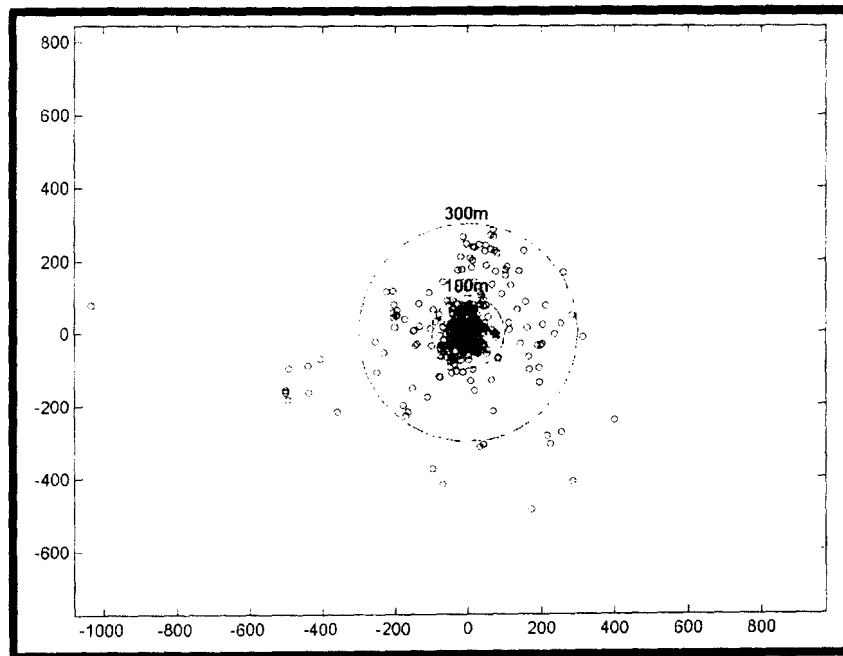


Figure 2: Composite location error scatter plot for all test points, best fix performance.

APPENDIX A: Data File Directory

STATIONARY FILES	MOBILE FILES
combined_s01.csv	0602MC2v01.csv
combined_s01a.csv	0602MC2v01a.csv
combined_s01b.csv	0602MC2v01b.csv
combined_s02.csv	0602MC4v01.csv
combined_s02a.csv	0602MC4v01a.csv
combined_s02b.csv	0602MC4v01b.csv
combined_s03.csv	0603MC2v02.csv
combined_s03a.csv	0603MC2v02a.csv
combined_s03b.csv	0603MC2v02b.csv
combined_s04.csv	0603MC4v02.csv
combined_s04a.csv	0603MC4v02a.csv
combined_s04b.csv	0603MC4v02b.csv
combined_s05.csv	0605MC4v03.csv
combined_s05a.csv	0605MC4v03a.csv
combined_s05b.csv	0605MC4v03b.csv
combined_s06.csv	0606MC2v03.csv
combined_s06a.csv	0606MC2v03a.csv
combined_s06b.csv	0606MC2v03b.csv
combined_s07.csv	0607MC4v04.csv
combined_s07a.csv	0607MC4v04a.csv
combined_s07b.csv	0607MC4v04b.csv
combined_s27.csv	
combined_s27a.csv	
combined_s27b.csv	
combined_s28.csv	
combined_s28a.csv	
combined_s28b.csv	
combined_s40.csv	
combined_s40a.csv	
combined_s40b.csv	
combined_s41.csv	
combined_s41a.csv	
combined_s41b.csv	

EXHIBIT C

Motorola Analysis of E-OTD Location Solution



MOTOROLA

Motorola Labs

*Wireless Access and Applications Research
Wireless Access & Physical Interface Lab*

To: Dan Isola
Kevin Gutzmer

Cc:

From: Mark Birchler

Date: October 23, 2000

Subject: iDEN 95%'tile E-OTD Accuracy Estimates with Sensitivity Analysis and with HAMRs for Potential Nextel E911 Phase 2 Waiver Request

Background

Motorola Labs has generated iDEN E-OTD 95%'tile simulated accuracy estimates as functions of:

- multipath environment type
- user speed
- indoor/outdoor use
- site geometry.

All of these are primary factors in limiting possible accuracy. However, there are additional factors that will have significant impact of delivered accuracy, the most important of which is system loading. This is the case because iDEN E-OTD relies primarily on use of known data patterns in Idle Slots (i.e., unused for control or traffic payloads) for time of arrival (TOA) measurement.

Other factors that will influence accuracy but which have yet to be fully explored are:

- environmental adaptive multipath rejection and fixer algorithms
- use of data directed TOA measurement when severe system loading limits the number of available Idle Slots and multiple
- use of multiple location estimates or longer signal measurement time spans.

Nextel has requested that Motorola provide baseline 95%'tile accuracy estimates for use in a potential E911 Phase 2 waiver request to the FCC. The following information seeks to use the best available simulation data, engineering judgement and population/environment information to generate these estimates.

The following table contains the raw information, assumptions and estimation algorithm utilized to estimate a single baseline accuracy estimate for iDEN based E-OTD location technology. All currently known information was combined to arrive at this estimate. The unknown factors will cause degradation or improvement to this baseline estimate. A fully developed and optimized E-OTD system should have a reasonable chance of achieving the baseline accuracy prediction.

Accuracy Analysis

Use Scenario Parameters				95%'tile Accuracy (m)	Simulation vs. Estimate	Assumed Use Scenario Probability	Use Scenario Weighted Accuracy (95%, m.) ^a	U.S. Population Weighting Factor ^b	U.S. Population Weighted Accuracy (95%, m) ^c
Multipath ^d Model	Speed (mph)	In/Out of Building	Site Geometry ^e						
Bad Urban	30	Out	Core	442	Sim.	0.05	695	0.04	27.8
	3	Out	Core	530	Sim.	0.10			
	1	Out	Core	620	Sim.	0.10			
	1	In	Core	693	Sim.	0.25			
	0.5	Out	Core	769	Sim.	0.50			
Urban A	30	Out	Core	225	Sim.	0.10	358	0.08	28.7
	3	Out	Core	245	Sim.	0.15			
	1	Out	Core	301	Sim.	0.15			
	1	In	Core	459	Sim.	0.25			
	0.5	Out	Core	396	Sim.	0.35			
Urban B	30	Out	Core	173	Sim.	0.15	314	0.13	40.8
	3	Out	Core	210	Sim.	0.20			
	1	In	Core	477	Sim.	0.25			
	1	Out	Core	277	Sim.	0.20			
	0.5	Out	Core	353	Sim.	0.20			
Suburban	30	Out	Core	141	Sim.	0.25	521	0.52	270.9
	3	Out	Fringe	3215	Sim.	0.10			
	3	Out	Core	183	Sim.	0.15			
	1	In	Core	267	Sim.	0.15			
	1	Out	Core	252	Sim.	0.20			
	0.5	Out	Core	308	Sim.	0.15			
Rural	30	Out	Core	60	Sim.	0.05	1193	0.23	274.3
	30	Out	Highway	309	Sim.	0.45			
	30	Out	Fringe	3215	Sim.	0.30			
	3	Out	Core	86	Sim.	0.05			
	3	Out	Highway	543	Est. ^f	0.15			
Total Estimated Accuracy (Use Scenario & U.S. Population Weighted, 95%'tile, m) ^g									643

Table 1 Total iDEN E-OTD 95%'tile Accuracy (with HAMRs) Estimate Worksheet

- Sum of the products of accuracies and use scenario probabilities for multipath environment
- Based on a 1990 U.S. Census report provided by Alavi Alexander
- Product of Use Scenario Weighted Accuracy and U.S. Population Weighting Factor
- Environments and corresponding simulation models created within and used by the T1P1.5 GSM location technology standardization group
- "Core" = Full ring of neighbor sites surrounding serving site; "Fringe" = All sites (serving and neighbor) on one side of the subscriber; "Highway" = Sites along a fairly straight highway, no sites located off the highway.
- Estimated value is equal to 3.4 times the 67%'tile value previously reported.
- Sum of U.S. Population Weighted Accuracies

Sensitivity Analysis

We believe that the two primary areas of uncertainty in this data are:

1. the accuracy of the multipath models
2. the accuracy of the assumed use scenario probabilities.

Therefore we will conduct an accuracy sensitivity analysis for each case.

Multipath Model Sensitivity

For this analysis we will assume that the multipath models are either one step too pessimistic or optimistic as compared to the real environments. Thus, we will rerun the accuracy estimates based on the following mapping between real and modeled environments.

Real Multipath Environment	Model Multipath Environment	Comments
Bad Urban	"Terrible Urban"	The "Terrible Urban" model does not exist, so we will have to generate accuracy estimates based on our best engineering judgement. We will assume that a "Terrible Urban" case will result in accuracies 50% worse than obtained for "Bad Urban"
Urban A	Bad Urban	
Urban B	Urban A	
Suburban	Urban B	
Rural	Suburban	

Table 2 Pessimistic Accuracy Case

Real Multipath Environment	Model Multipath Environment	Comments
Bad Urban	Urban A	
Urban A	Urban B	
Urban B	Suburban	
Suburban	Rural	
Rural	"Open Spaces"	The "Open Spaces" model does not exist, so we will have to generate accuracy estimates based on our best engineering judgement. We will assume that a "Terrible Urban" case will result in accuracies 50% better than obtained for "Rural"

Table 3 Optimistic Accuracy Case

The following two tables contain the data and outputs resulting from the above two assumptions.

Use Scenario Parameters				95% 'tile Accuracy (m)	Simulation vs. Estimate	Assumed Use Scenario Probability	Use Scenario Weighted Accuracy (95 %, m.) ^a	U.S. Population Weighting Factor ^b	U.S. Population Weighted Accuracy (95 %, m) ^c
Multipath ^d Model	Speed (mph)	In/Out of Building	Site Geometry ^e						
“Terrible Urban” ^f	30	Out	Core	663	Est.	0.05	1043	0.04	41.8
	3	Out	Core	795	Est.	0.10			
	1	Out	Core	930	Est.	0.10			
	1	In	Core	1040	Est.	0.25			
	0.5	Out	Core	1154	Est.	0.50			
Bad Urban	30	Out	Core	442	Sim.	0.10	660	0.08	52.8
	3	Out	Core	530	Sim.	0.15			
	1	Out	Core	620	Sim.	0.15			
	1	In	Core	693	Sim.	0.25			
	0.5	Out	Core	769	Sim.	0.35			
Urban A	30	Out	Core	225	Sim.	0.15	337	0.13	43.8
	3	Out	Core	245	Sim.	0.20			
	1	In	Core	459	Sim.	0.25			
	1	Out	Core	301	Sim.	0.20			
	0.5	Out	Core	396	Sim.	0.20			
Urban B	30	Out	Core	173	Sim.	0.25	577	0.52	299.6
	3	Out	Fringe	3215	Sim.	0.10			
	3	Out	Core	210	Sim.	0.15			
	1	In	Core	477	Sim.	0.15			
	1	Out	Core	277	Sim.	0.20			
	0.5	Out	Core	353	Sim.	0.15			
Suburban	30	Out	Core	141	Sim.	0.05	1345	0.23	309.2
	30	Out	Highway	564	Est. ^g	0.45			
	30	Out	Fringe	3215	Sim.	0.30			
	3	Out	Core	183	Sim.	0.05			
	3	Out	Highway	732	Est. ^g	0.15			
Total Estimated Accuracy (Use Scenario & U.S. Population Weighted, 95% 'tile, m) ^h									748

Table 4 Pessimistic Multipath Total iDEN E-OTD 95% Accuracy (with HAMRs) Estimate Worksheet

a. Sum of the products of accuracies and use scenario probabilities for multipath environment

b. Based on a 1990 U.S. Census report provided by Alavi Alexander

c. Product of Use Scenario Weighted Accuracy and U.S. Population Weighting Factor

d. Environments and corresponding simulation models created within and used by the T1P1.5 GSM location technology standardization group

e. "Core" = Full ring of neighbor sites surrounding serving site; "Fringe" = All sites (serving and neighbor) on one side of the subscriber; "Highway" = Sites along a fairly straight highway, no sites located off the highway.

f. This model does not exist in T1P1.5 so we assumed 50% worse accuracy than for Bad Urban

g. Estimated value is equal to 4 times the 95% 'tile value for the same conditions.

h. Sum of U.S. Population Weighted Accuracies

Use Scenario Parameters				95% 'tile Accuracy (m)	Simulation vs. Estimate	Assumed Use Scenario Probability	Use Scenario Weighted Accuracy (95%, m.) ^a	U.S. Population Weighting Factor ^b	U.S. Population Weighted Accuracy (95%, m) ^c
Multipath ^d Model	Speed (mph)	In/Out of Building	Site Geometry ^e						
Urban A	30	Out	Core	225	Sim.	0.05	379	0.04	15.2
	3	Out	Core	245	Sim.	0.10			
	1	Out	Core	301	Sim.	0.10			
	1	In	Core	459	Sim.	0.25			
	0.5	Out	Core	396	Sim.	0.50			
Urban B	30	Out	Core	173	Sim.	0.10	334	0.08	26.7
	3	Out	Core	210	Sim.	0.15			
	1	Out	Core	277	Sim.	0.15			
	1	In	Core	477	Sim.	0.25			
	0.5	Out	Core	353	Sim.	0.35			
Suburban	30	Out	Core	141	Sim.	0.15	237	0.13	30.8
	3	Out	Core	183	Sim.	0.20			
	1	In	Core	267	Sim.	0.25			
	1	Out	Core	252	Sim.	0.20			
	0.5	Out	Core	308	Sim.	0.20			
Rural	30	Out	Core	60	Sim.	0.25	419	0.52	217.7
	3	Out	Fringe	3215	Sim.	0.10			
	3	Out	Core	86	Sim.	0.15			
	1	In	Core	140	Sim.	0.15			
	1	Out	Core	124	Sim.	0.20			
	0.5	Out	Core	156	Sim.	0.15			
"Open Spaces" ^f	30	Out	Core	40	Est.	0.05	796	0.23	182.9
	30	Out	Highway	206	Est.	0.45			
	30	Out	Fringe	2144	Est.	0.30			
	3	Out	Core	58	Est.	0.05			
	3	Out	Highway	362	Est.	0.15			
Total Estimated Accuracy (Use Scenario & U.S. Population Weighted, 95% 'tile, m) ^g									474

Table 5 Optimistic Multipath Total iDEN E-OTD 95% Accuracy (with HAMRs) Estimate Worksheet

a. Sum of the products of accuracies and use scenario probabilities for multipath environment

b. Based on a 1990 U.S. Census report provided by Alavi Alexander

c. Product of Use Scenario Weighted Accuracy and U.S. Population Weighting Factor

d. Environments and corresponding simulation models created within and used by the T1P1.5 GSM location technology standardization group

e. "Core" = Full ring of neighbor sites surrounding serving site; "Fringe" = All sites (serving and neighbor) on one side of the subscriber; "Highway" = Sites along a fairly straight highway, no sites located off the highway.

f. This model does not exist in T1P1.5 so we assumed 50% better accuracy than for Rural

g. Sum of U.S. Population Weighted Accuracies

Use Scenario Probability Sensitivity

For this sensitivity analysis we will modify the use scenario probabilities in the optimistic and pessimistic directions. On the optimistic side, good use scenario probabilities will be increased at the expense of bad scenario probabilities, and vice versa for the pessimistic case. The following tables show the resulting data and outputs.

Use Scenario Parameters				95%'tile Accuracy (m)	Simulation vs. Estimate	Assumed Use Scenario Probability	Use Scenario Weighted Accuracy (95%, m.) ^a	U.S. Population Weighting Factor ^b	U.S. Population Weighted Accuracy (95%, m) ^c
Multipath ^d Model	Speed (mph)	In/Out of Building	Site Geometry ^e						
Bad Urban	30	Out	Core	442	Sim.	0.00	732	0.04	29.3
	3	Out	Core	530	Sim.	0.00			
	1	Out	Core	620	Sim.	0.10			
	1	In	Core	693	Sim.	0.30			
	0.5	Out	Core	769	Sim.	0.60			
Urban A	30	Out	Core	225	Sim.	0.00	389	0.08	31.2
	3	Out	Core	245	Sim.	0.05			
	1	Out	Core	301	Sim.	0.20			
	1	In	Core	459	Sim.	0.30			
	0.5	Out	Core	396	Sim.	0.45			
Urban B	30	Out	Core	173	Sim.	0.05	348	0.13	45.3
	3	Out	Core	210	Sim.	0.10			
	1	In	Core	477	Sim.	0.30			
	1	Out	Core	277	Sim.	0.25			
	0.5	Out	Core	353	Sim.	0.30			
Suburban	30	Out	Core	141	Sim.	0.15	683	0.52	355.2
	3	Out	Fringe	3215	Est.	0.15			
	3	Out	Core	183	Sim.	0.15			
	1	In	Core	267	Sim.	0.15			
	1	Out	Core	252	Sim.	0.20			
	0.5	Out	Core	308	Sim.	0.20			
Rural	30	Out	Core	60	Sim.	0.00	1664	0.23	382.7
	30	Out	Highway	309	Sim.	0.35			
	30	Out	Fringe	3215	Sim.	0.45			
	3	Out	Core	86	Sim.	0.00			
	3	Out	Highway	543	Est. ^f	0.20			
Total Estimated Accuracy (Use Scenario & U.S. Population Weighted, 95%'tile, m) ^g									844

Table 6 Pessimistic Use Total iDEN E-OTD 95% Accuracy (with HAMRs) Estimate Worksheet

- a. Sum of the products of accuracies and use scenario probabilities for multipath environment
- b. Based on a 1990 U.S. Census report provided by Alavi Alexander
- c. Product of Use Scenario Weighted Accuracy and U.S. Population Weighting Factor

d. Environments and corresponding simulation models created within and used by the T1P1.5 GSM location technology standardization group

e. "Core" = Full ring of neighbor sites surrounding serving site; "Fringe" = All sites (serving and neighbor) on one side of the subscriber; "Highway" = Sites along a fairly straight highway, no sites located off the highway.

f. Estimated value is equal to 3.4 times the 67% tile value previously reported.

g. Sum of U.S. Population Weighted Accuracies

Use Scenario Parameters				95% 'tile Accuracy (m)	Simulation vs. Estimate	Assumed Use Scenario Probability	Use Scenario Weighted Accuracy (95%, m.) ^a	U.S. Population Weighting Factor ^b	U.S. Population Weighted Accuracy (95%, m) ^c
Multipath ^d Model	Speed (mph)	In/Out of Building	Site Geometry ^e						
Bad Urban	30	Out	Core	442	Sim.	0.15	615	0.04	24.6
	3	Out	Core	530	Sim.	0.30			
	1	Out	Core	620	Sim.	0.15			
	1	In	Core	693	Sim.	0.15			
	0.5	Out	Core	769	Sim.	0.25			
Urban A	30	Out	Core	225	Sim.	0.20	309	0.08	24.8
	3	Out	Core	245	Sim.	0.35			
	1	Out	Core	301	Sim.	0.10			
	1	In	Core	459	Sim.	0.15			
	0.5	Out	Core	396	Sim.	0.20			
Urban B	30	Out	Core	173	Sim.	0.25	262	0.13	34.1
	3	Out	Core	210	Sim.	0.40			
	1	In	Core	477	Sim	0.15			
	1	Out	Core	277	Sim.	0.10			
	0.5	Out	Core	353	Sim.	0.10			
Suburban	30	Out	Core	141	Sim.	0.40	346	0.52	179.8
	3	Out	Fringe	3215	Sim.	0.05			
	3	Out	Core	183	Sim.	0.25			
	1	In	Core	267	Sim.	0.10			
	1	Out	Core	252	Sim.	0.10			
	0.5	Out	Core	308	Sim.	0.10			
Rural	30	Out	Core	60	Sim.	0.15	832	0.23	191.3
	30	Out	Highway	309	Sim.	0.35			
	30	Out	Fringe	3215	Sim.	0.20			
	3	Out	Core	86	Sim.	0.20			
	3	Out	Highway	543	Est. ^f	0.10			
Total Estimated Accuracy (Use Scenario & U.S. Population Weighted, 95% 'tile, m) ^g									455

Table 7 Optimistic Use Total iDEN E-OTD 95% Accuracy (with HAMRs) Estimate Worksheet

a. Sum of the products of accuracies and use scenario probabilities for multipath environment

b. Based on a 1990 U.S. Census report provided by Alavi Alexander

c. Product of Use Scenario Weighted Accuracy and U.S. Population Weighting Factor

- d. Environments and corresponding simulation models created within and used by the T1P1.5 GSM location technology standardization group
- e. "Core" = Full ring of neighbor sites surrounding serving site; "Fringe" = All sites (serving and neighbor) on one side of the subscriber; "Highway" = Sites along a fairly straight highway, no sites located off the highway.
- f. Estimated value is equal to 3.4 times the 67% tile value previously reported.
- g. Sum of U.S. Population Weighted Accuracies

Regards,

Mark



MOTOROLA

Motorola Labs

*Wireless Access and Applications Research
Wireless Access & Physical Interface Lab*

To: Dan Isola
Kevin Gutzmer

Cc:

From: Mark Birchler

Date: October 13, 2000

Subject: iDEN E-OTD Accuracy Estimates with HAMRs for Potential Nextel E911 Phase 2 Waiver Request

Background

Motorola Labs has generated iDEN E-OTD accuracy estimates as functions of:

- multipath environment type
- user speed
- indoor/outdoor use
- site geometry.

All of these are primary factors in limiting possible accuracy. However, there are additional factors that will have significant impact of delivered accuracy, the most important of which is system loading. This is the case because iDEN E-OTD relies primarily on use of known data patterns in Idle Slots (i.e., unused for control or traffic payloads) for time of arrival (TOA) measurement.

Other factors that will influence accuracy but which have yet to be fully explored are:

- environmental adaptive multipath rejection and fixer algorithms
- use of data directed TOA measurement when severe system loading limits the number of available Idle Slots and multiple
- use of multiple location estimates or longer signal measurement time spans

Nextel has requested that Motorola provide baseline accuracy estimate for use in a potential E911 Phase 2 waiver request to the FCC. The following information seeks to use the best available simulation data, engineering judgement and population/environment information to generate this estimate.

The following table contains the raw information, assumptions and estimation algorithm utilized to estimate a single baseline accuracy estimate for iDEN based E-OTD location technology. All currently known information was combined to arrive at this estimate. The unknown factors will cause degradation or improvement to this baseline estimate. A fully developed and optimized E-OTD system should have a reasonable chance of achieving the baseline accuracy prediction.

Accuracy Analysis

Use Scenario Parameters				67 %'tile Accuracy (m)	Simulation vs. Estimate	Assumed Use Scenario Probability	Use Scenario Weighted Accuracy (67 %, m.) ^a	U.S. Population Weighting Factor ^b	U.S. Population Weighted Accuracy (67 %, m) ^c
Multipath ^d Model	Speed (mph)	In/Out of Building	Site Geometry ^e						
Bad Urban	30	Out	Core	191	Sim.	0.05	328	0.04	13.1
	3	Out	Core	216	Sim.	0.10			
	1	Out	Core	275	Sim.	0.10			
	1	In	Core	415	Est.	0.25			
	0.5	Out	Core	331	Sim.	0.50			
Urban A	30	Out	Core	104	Sim.	0.10	159	0.08	12.7
	3	Out	Core	115	Sim.	0.15			
	1	Out	Core	138	Sim.	0.15			
	1	In	Core	210	Est.	0.25			
	0.5	Out	Core	164	Sim.	0.35			
Urban B	30	Out	Core	87	Sim.	0.15	134	0.13	17.4
	3	Out	Core	104	Sim.	0.20			
	3	In	Core	165	Sim	0.25			
	1	Out	Core	133	Sim.	0.20			
	0.5	Out	Core	160	Sim.	0.20			
Suburban	30	Out	Core	69	Sim.	0.25	122	0.52	63.4
	3	Out	Fringe	310	Sim.	0.10			
	3	Out	Core	91	Sim.	0.15			
	3	In	Core	110	Sim.	0.15			
	1	Out	Core	116	Sim.	0.20			
	0.5	Out	Core	136	Sim.	0.15			
Rural	30	Out	Core	33	Sim.	0.05	174	0.23	40.0
	30	Out	Highway	91	Sim.	0.45			
	30	Out	Fringe	350	Est.	0.30			
	3	Out	Core	50	Sim.	0.05			
	3	Out	Highway	160	Est.	0.15			
Total Estimated Accuracy (Use Scenario & U.S. Population Weighted, 67 %'tile, m) ^f									147

Table 1 Total iDEN E-OTD Accuracy (with HAMRs) Estimate Worksheet

- Sum of the products of accuracies and use scenario probabilities for multipath environment
- Based on a 1990 U.S. Census report provided by Alavi Alexander
- Product of Use Scenario Weighted Accuracy and U.S. Population Weighting Factor
- Environments and corresponding simulation models created within and used by the T1P1.5 GSM location technology standardization group
- "Core" = Full ring of neighbor sites surrounding serving site; "Fringe" = All sites (serving and neighbor) on one side of the subscriber; "Highway" = Sites along a fairly straight highway, no sites located off the highway.
- Sum of U.S. Population Weighted Accuracies

Sensitivity Analysis

We believe that the two primary areas of uncertainty in this data are:

1. the accuracy of the multipath models
2. the accuracy of the assumed use scenario probabilities.

Therefore we will conduct an accuracy sensitivity analysis for each case.

Multipath Model Sensitivity

For this analysis we will assume that the multipath models are either one step too pessimistic or optimistic as compared to the real environments. Thus, we will rerun the accuracy estimates based on the following mapping between real and modeled environments.

Real Multipath Environment	Model Multipath Environment	Comments
Bad Urban	"Terrible Urban"	The "Terrible Urban" model does not exist, so we will have to generate accuracy estimates based on our best engineering judgement. We will assume that a "Terrible Urban" case will result in accuracies 50% worse than obtained for "Bad Urban"
Urban A	Bad Urban	
Urban B	Urban A	
Suburban	Urban B	
Rural	Suburban	

Table 2 Pessimistic Accuracy Case

Real Multipath Environment	Model Multipath Environment	Comments
Bad Urban	Urban A	
Urban A	Urban B	
Urban B	Suburban	
Suburban	Rural	
Rural	"Open Spaces"	The "Open Spaces" model does not exist, so we will have to generate accuracy estimates based on our best engineering judgement. We will assume that a "Terrible Urban" case will result in accuracies 50% better than obtained for "Rural"

Table 3 Optimistic Accuracy Case

The following two tables contain the data and outputs resulting from the above two assumptions.

Use Scenario Parameters				67% 'tile Accuracy (m)	Simulation vs. Estimate	Assumed Use Scenario Probability	Use Scenario Weighted Accuracy (67%, m.) ^a	U.S. Population Weighting Factor ^b	U.S. Population Weighted Accuracy (67%, m) ^c
Multipath ^d Model	Speed (mph)	In/Out of Building	Site Geometry ^e						
"Terrible Urban" ^f	30	Out	Core	287	Est..	0.05	492.3	0.04	19.7
	3	Out	Core	324	Est..	0.10			
	1	Out	Core	413	Est..	0.10			
	1	In	Core	623	Est.	0.25			
	0.5	Out	Core	497	Est..	0.50			
Bad Urban	30	Out	Core	191	Sim.	0.10	312.4	0.08	25.0
	3	Out	Core	216	Sim.	0.15			
	1	Out	Core	275	Sim.	0.15			
	1	In	Core	415	Est.	0.25			
	0.5	Out	Core	331	Sim.	0.35			
Urban a	30	Out	Core	104	Sim.	0.15	151.5	0.13	19.7
	3	Out	Core	115	Sim.	0.20			
	3	In	Core	210	Sim.	0.25			
	1	Out	Core	138	Sim.	0.20			
	0.5	Out	Core	164	Sim.	0.20			
Urban B	30	Out	Core	87	Sim.	0.25	147.7	0.52	76.8
	3	Out	Fringe	350	Sim.	0.10			
	3	Out	Core	104	Sim.	0.15			
	3	In	Core	165	Sim.	0.15			
	1	Out	Core	133	Sim.	0.20			
	0.5	Out	Core	160	Sim.	0.15			
Suburban	30	Out	Core	69	Sim.	0.05	203.0	0.23	46.7
	30	Out	Highway	140	Sim.	0.45			
	30	Out	Fringe	350	Est.	0.30			
	3	Out	Core	91	Sim.	0.05			
	3	Out	Highway	180	Est.	0.15			
Total Estimated Accuracy (Use Scenario & U.S. Population Weighted, 67% 'tile, m) ^g									188

Table 4 Pessimistic Multipath Total iDEN E-OTD Accuracy (with HAMRs) Estimate Worksheet

a. Sum of the products of accuracies and use scenario probabilities for multipath environment

b. Based on a 1990 U.S. Census report provided by Alavi Alexander

c. Product of Use Scenario Weighted Accuracy and U.S. Population Weighting Factor

d. Environments and corresponding simulation models created within and used by the T1P1.5 GSM location technology standardization group

e. "Core" = Full ring of neighbor sites surrounding serving site; "Fringe" = All sites (serving and neighbor) on one side of the subscriber; "Highway" = Sites along a fairly straight highway, no sites located off the highway.

f. This model does not exist in T1P1.5 so we assumed 50% worse accuracy than for Bad Urban

g. Sum of U.S. Population Weighted Accuracies

Use Scenario Parameters				67 %'tile Accuracy (m)	Simulation vs. Estimate	Assumed Use Scenario Probability	Use Scenario Weighted Accuracy (67 %, m.) ^a	U.S. Population Weighting Factor ^b	U.S. Population Weighted Accuracy (67 %, m) ^c
Multipath ^d Model	Speed (mph)	In/Out of Building	Site Geometry ^e						
Urban A	30	Out	Core	104	Sim.	0.05	165.0	0.04	6.6
	3	Out	Core	115	Sim.	0.10			
	1	Out	Core	138	Sim.	0.10			
	1	In	Core	210	Est.	0.25			
	0.5	Out	Core	164	Sim.	0.50			
Urban B	30	Out	Core	87	Sim.	0.10	141.5	0.08	11.3
	3	Out	Core	104	Sim.	0.15			
	1	Out	Core	133	Sim.	0.15			
	1	In	Core	165	Est.	0.25			
	0.5	Out	Core	160	Sim.	0.35			
Suburban	30	Out	Core	69	Sim.	0.15	106.5	0.13	13.8
	3	Out	Core	91	Sim.	0.20			
	3	In	Core	110	Sim	0.25			
	1	Out	Core	116	Sim.	0.20			
	0.5	Out	Core	136	Sim.	0.20			
Rural	30	Out	Core	33	Sim.	0.25	83.0	0.52	43.1
	3	Out	Fringe	300	Sim.	0.10			
	3	Out	Core	50	Sim.	0.15			
	3	In	Core	75	Sim.	0.15			
	1	Out	Core	66	Sim.	0.20			
	0.5	Out	Core	85	Sim.	0.15			
"Open Spaces" ^f	30	Out	Core	22	Est..	0.05	116.2	0.23	26.7
	30	Out	Highway	61	Est..	0.45			
	30	Out	Fringe	233	Est..	0.30			
	3	Out	Core	33	Est..	0.05			
	3	Out	Highway	107	Est.	0.15			
Total Estimated Accuracy (Use Scenario & U.S. Population Weighted, 67 %'tile, m) ^g									102

Table 5 Optimistic Multipath Total iDEN E-OTD Accuracy (with HAMRs) Estimate Worksheet

a. Sum of the products of accuracies and use scenario probabilities for multipath environment

b. Based on a 1990 U.S. Census report provided by Alavi Alexander

c. Product of Use Scenario Weighted Accuracy and U.S. Population Weighting Factor

d. Environments and corresponding simulation models created within and used by the T1P1.5 GSM location technology standardization group

e. "Core" = Full ring of neighbor sites surrounding serving site; "Fringe" = All sites (serving and neighbor) on one side of the subscriber; "Highway" = Sites along a fairly straight highway, no sites located off the highway.

f. This model does not exist in T1P1.5 so we assumed 50% better accuracy than for Rural

g. Sum of U.S. Population Weighted Accuracies

Use Scenario Probability Sensitivity

For this sensitivity analysis we will modify the use scenario probabilities in the optimistic and pessimistic directions. On the optimistic side, good use scenario probabilities will be increased at the expense of bad scenario probabilities, and vice versa for the pessimistic case. The following tables show the resulting data and outputs.

Use Scenario Parameters				67%'tile Accuracy (m)	Simulation vs. Estimate	Assumed Use Scenario Probability	Use Scenario Weighted Accuracy (67%, m.) ^a	U.S. Population Weighting Factor ^b	U.S. Population Weighted Accuracy (67%, m) ^c
Multipath ^d Model	Speed (mph)	In/Out of Building	Site Geometry ^e						
Bad Urban	30	Out	Core	191	Sim.	0.00	350.6	0.04	14.0
	3	Out	Core	216	Sim.	0.00			
	1	Out	Core	275	Sim.	0.10			
	1	In	Core	415	Est.	0.30			
	0.5	Out	Core	331	Sim.	0.60			
Urban A	30	Out	Core	104	Sim.	0.00	170.2	0.08	13.6
	3	Out	Core	115	Sim.	0.05			
	1	Out	Core	138	Sim.	0.20			
	1	In	Core	210	Est.	0.30			
	0.5	Out	Core	164	Sim.	0.45			
Urban B	30	Out	Core	87	Sim.	0.05	145.5	0.13	18.9
	3	Out	Core	104	Sim.	0.10			
	3	In	Core	165	Sim	0.30			
	1	Out	Core	133	Sim.	0.25			
	0.5	Out	Core	160	Sim.	0.30			
Suburban	30	Out	Core	69	Sim.	0.15	137.4	0.52	71.4
	3	Out	Fringe	310	Sim.	0.15			
	3	Out	Core	91	Sim.	0.15			
	3	In	Core	110	Sim.	0.15			
	1	Out	Core	116	Sim.	0.20			
	0.5	Out	Core	136	Sim.	0.20			
Rural	30	Out	Core	33	Sim.	0.00	221.4	0.23	50.9
	30	Out	Highway	91	Sim.	0.35			
	30	Out	Fringe	350	Est.	0.45			
	3	Out	Core	50	Sim.	0.00			
	3	Out	Highway	160	Est.	0.20			
Total Estimated Accuracy (Use Scenario & U.S. Population Weighted, 67%'tile, m) ^f									169

Table 6 Pessimistic Use Total iDEN E-OTD Accuracy (with HAMRs) Estimate Worksheet

- a. Sum of the products of accuracies and use scenario probabilities for multipath environment
- b. Based on a 1990 U.S. Census report provided by Alavi Alexander
- c. Product of Use Scenario Weighted Accuracy and U.S. Population Weighting Factor

d. Environments and corresponding simulation models created within and used by the T1P1.5 GSM location technology standardization group

e. "Core" = Full ring of neighbor sites surrounding serving site; "Fringe" = All sites (serving and neighbor) on one side of the subscriber; "Highway" = Sites along a fairly straight highway, no sites located off the highway.

f. Sum of U.S. Population Weighted Accuracies

Use Scenario Parameters				67%'tile Accuracy (m)	Simulation vs. Estimate	Assumed Use Scenario Probability	Use Scenario Weighted Accuracy (67%, m.) ^a	U.S. Population Weighting Factor ^b	U.S. Population Weighted Accuracy (67%, m) ^c
Multipath ^d Model	Speed (mph)	In/Out of Building	Site Geometry ^e						
Bad Urban	30	Out	Core	191	Sim.	0.15	279.7	0.04	11.2
	3	Out	Core	216	Sim.	0.30			
	1	Out	Core	275	Sim.	0.15			
	1	In	Core	415	Est.	0.15			
	0.5	Out	Core	331	Sim.	0.25			
Urban A	30	Out	Core	104	Sim.	0.20	139.2	0.08	11.1
	3	Out	Core	115	Sim.	0.35			
	1	Out	Core	138	Sim.	0.10			
	1	In	Core	210	Est.	0.15			
	0.5	Out	Core	164	Sim.	0.20			
Urban B	30	Out	Core	87	Sim.	0.25	117.4	0.13	15.3
	3	Out	Core	104	Sim.	0.40			
	3	In	Core	165	Sim.	0.15			
	1	Out	Core	133	Sim.	0.10			
	0.5	Out	Core	160	Sim.	0.10			
Suburban	30	Out	Core	69	Sim.	0.40	102.1	0.52	53.1
	3	Out	Fringe	310	Sim.	0.05			
	3	Out	Core	91	Sim.	0.25			
	3	In	Core	110	Sim.	0.10			
	1	Out	Core	116	Sim.	0.10			
	0.5	Out	Core	136	Sim.	0.10			
Rural	30	Out	Core	33	Sim.	0.15	132.8	0.23	30.5
	30	Out	Highway	91	Sim.	0.35			
	30	Out	Fringe	350	Est.	0.20			
	3	Out	Core	50	Sim.	0.20			
	3	Out	Highway	160	Est.	0.10			
Total Estimated Accuracy (Use Scenario & U.S. Population Weighted, 67%'tile, m) ^f									122

Table 7 Optimistic Use Total iDEN E-OTD Accuracy (with HAMRs) Estimate Worksheet

a. Sum of the products of accuracies and use scenario probabilities for multipath environment

b. Based on a 1990 U.S. Census report provided by Alavi Alexander

c. Product of Use Scenario Weighted Accuracy and U.S. Population Weighting Factor

- d. Environments and corresponding simulation models created within and used by the T1P1.5 GSM location technology standardization group
- e. "Core" = Full ring of neighbor sites surrounding serving site; "Fringe" = All sites (serving and neighbor) on one side of the subscriber; "Highway" = Sites along a fairly straight highway, no sites located off the highway.
- f. Sum of U.S. Population Weighted Accuracies

The following figure shows the potential range of 67%'tile accuracy given these two sensitivity analyses.

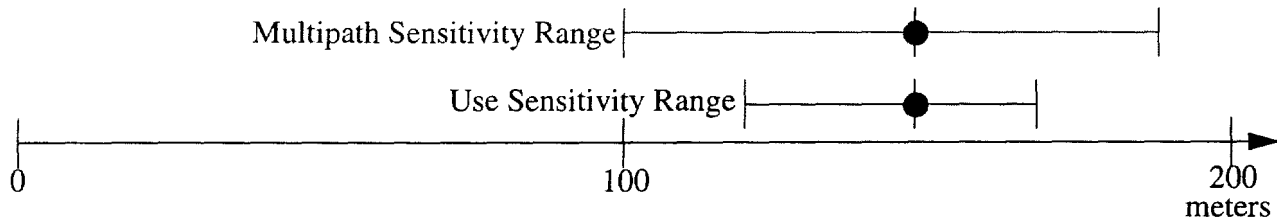


Figure 1 iDEN 67% Accuracy Ranges

Regards,

Mark